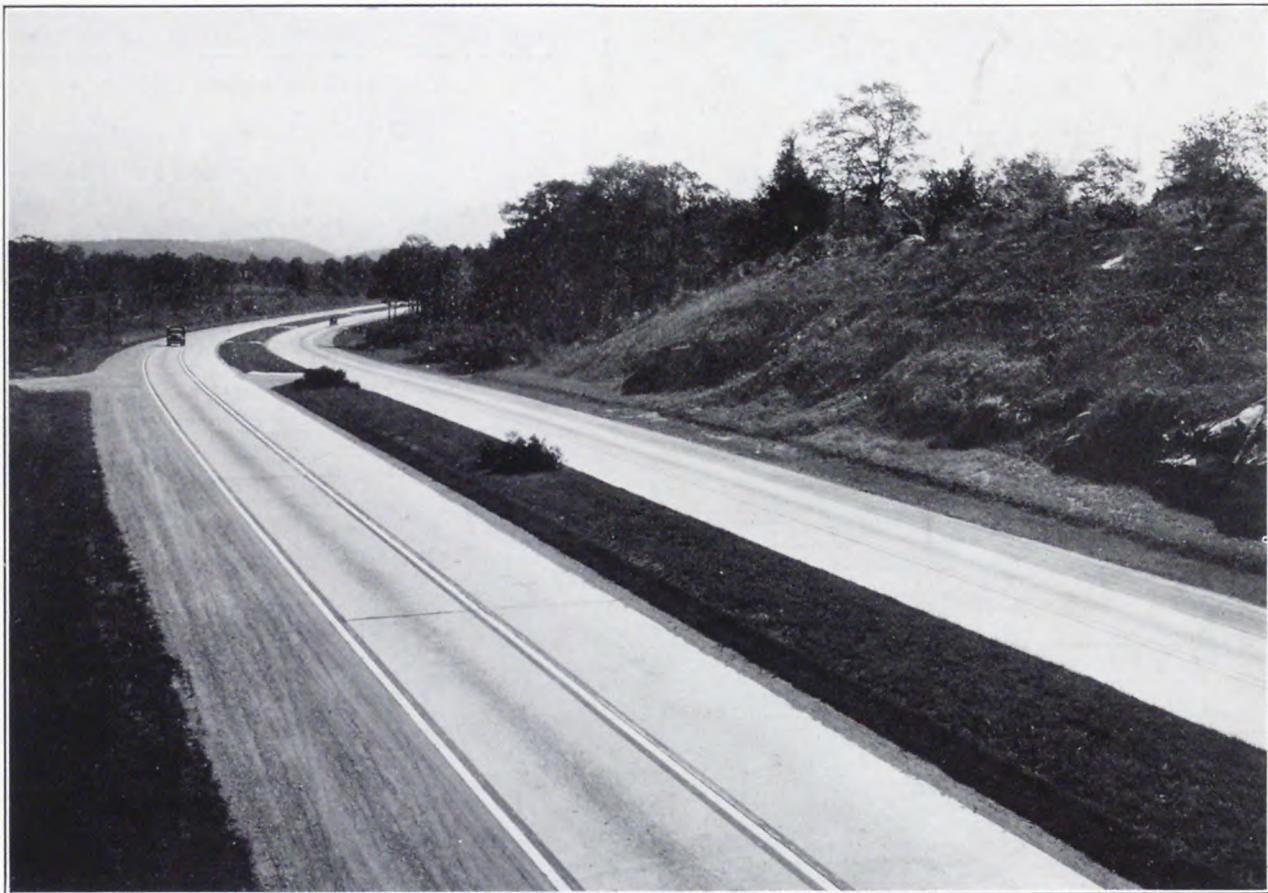


# NEWARK ENGINEERING NOTES



*The State of New Jersey is noted for its fine highways*

Photograph courtesy of E. Donald Sterner, State Highway Commissioner of New Jersey

VOLUME 2  
NUMBER 5  
MARCH, 1939



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## THE PRESIDENT'S DIARY

### March 2—*Alumni Participation*

Following the thought which I tried to express in my last entry concerning the help that an institution of this character could be with education in some of the practical phases of democracy, the one difficulty which seems to stand in the way of the development of the program is the participation of the graduates.

There is one thing which becomes more and more important as the years go on, and that is our Alumni Organization. We have had in the Night School for many years a body of alumni whose members have more than reached a place of considerable prominence in the community along both professional and business lines. The College Alumni, although the first class graduated in 1923, are reaching maturity and many of these young men are forging ahead into positions of considerable importance in the technical field.

From time to time I am consulted by both groups with respect to my feelings concerning an Alumni Organization; whether we ought to have a Technical School Alumni as separate from the College, or just how an Alumni Organization should work, and as to its form. It seems to me that the feeling is that an institution without an Alumni Organization lacks something which every well-ordered and well-regulated institution should have.

So far as my own thoughts are concerned, in the utmost frankness, it seems to me that an organization of alumni of a technical or engineering institution, if there is to be an organization, must have something in the way of pretty evident and direct objectives. I think that in an organization of this kind there should be something specific and continuous which the alumni can do for the institution and something specific and continuous which the institution can do for the alumni. After all, in this practical world it is a question of give and take, and it is hardly to be expected that the old traditional idea of the alumni group should persist beyond its real period of usefulness.

The traditional idea that most alumni groups have of celebrating with an annual dinner at which the President of the institution speaks and where in addition prominent members of the alumni, some with money, some without, tell what is wrong with the world, is very well in its own sphere, but it grows tiresome. In this day and generation we can get that sort of thing pretty well at home over the radio. Then there comes to mind seats at the football game or scouts in high schools where alumni who look for promising athletes while faced with the sometimes almost impossible specification of men with brawn and brains at the same time.

So that as far as alumni associations are concerned, it seems to me that ours should be along a little different line from the traditional one and should be integrated very very much closer with the social and professional life, the community life, and the political life of each individual in the organization. I think that such an organization can be built up. I can go even further and say that I think we are building up such an organization at the moment. You will hear something about it. You will be asked very probably to join with us, and I think, when you have considered the thing from all angles, you will see its desirability both from the standpoint of the institution and from the standpoint of your own advancement along all lines.

### March 8—*Something Specific*

To be specific, in the last week there have come to my attention a very considerable number of cases where one of our alumni might be of very distinct use to the institution and at the same time further his own professional advancement to a considerable extent. These cases have to do with meetings of engineering

societies. In several cases we have been able to pick out men in our own alumni group who were capable of adding to the program and entering into the discussion of the papers. We have indicated to them the desirability of so doing and extended to them an invitation to represent themselves, their profession, and the school in this regard. This is not only important from the professional advancement of the individual but extremely important with regard to the extension of the name and the influence of the school throughout the professional field hereabouts. Beyond that it gives us material which is usable in general publicity not only in our metropolitan newspapers but in our professional journals and in our suburban newspapers as well. Such following publicity is beneficial for the institution and for the individual.

In at least three cases we have been asked to participate in inaugural academic ceremonies, and this has been passed on to graduates who are in the particular neighborhood. One, as I remember it, was in Washington, one in Denver, Colorado, and one in North Carolina. I have on my desk just at this moment a letter which has come inviting participation in the Second Annual Anthracite Conference at Lehigh University in Bethlehem, and it is very desirable that we be represented there by some members of our alumni who have had experience along this line and who can take some real and active part in the discussion. The matter of the attendance of our alumni and their participation in these affairs should be brought to the attention of professional journals and to the local press, and this participation should be extremely beneficial to all concerned.

It seems to me that this is just exactly the thing which we want to do in the way of general publicity. As a State institution, we spend no money in advertising, but it is incumbent upon us to have the community know the type of men that we turn out, know something of our technical ability, and something of our ability in connection with general civic duties.

Of course in giving these instances I have only touched the fringe of alumni participation and we hope to use individual alumni with respect to prospective students in our own areas. We hope to use alumni with respect to both graduates and undergraduates who are not seemingly making the proper professional contacts on the outside. In a word, we believe that the average alumnus will want to help when he finds that he derives a considerable individual professional benefit from his associations with us, and particularly if, in addition to this individual personal benefit, he is rendering the institution a distinct service.

### March 17—*The Organization Contemplated*

We have, therefore, set up tentatively and roughly four general committees which we call the Committees on Public Relations: (1) Night School Alumni, (2) College Alumni, (3) Night School Students, (4) College Students. These four committees are to be associated in one General Council of twelve men with Mr. Kiernan acting as Executive Secretary of the General Council on Public Relations through which all requests for alumni participation are handled.

The Night School Alumni and College Alumni Committees are entirely separate, will have their own organization, and will function through their representatives on the General Council. Both groups are being handled by a Steering Committee which will outline proper organizations particularly considering the desirability of extending the organization on a territorial or company basis, that is, the placing of some of our committees in various territories throughout the State or in various organizations where the men hold positions.

At least if you are approached on the proposition you will know something of it, and if you have any suggestions to make you will be free to make them.



# MOLECULAR SPECTRA

By FRANK D. CARVIN, M.E., Ph.D.

*Professor of Mechanical Engineering, Newark College of Engineering*

Most of us, no doubt, are somewhat familiar with the general developments in the field of theoretical physics dealing with atomic spectra. With the development of the Bohr atom model, research in atomic physics was accelerated. The Bohr model pictured the atom as a positively charged nucleus about which one or more negatively charged electrons revolved in certain orbits. According to classical mechanics, such a system should emit radiation that has the same frequency as its own rotation in its orbit, or multiples of this frequency. However, the spectra of atoms are much more complex than this theory predicts. Bohr's first contribution was to predict the existence of certain stationary orbits for the electron and to permit radiation only when the electron changed from one orbit to another. Each orbit had a different energy level,  $E_1, E_2, E_3$ , etc., and the frequency of radiation was related to the change of energy by the relation

$$(E_2 - E_1) = h\nu$$

where  $h$  is Planck's constant and  $\nu$  is the frequency of vibration. The energy  $E$  can be calculated by classical mechanics, it being the sum of the kinetic and potential energy of the system.

Bohr's theory is best known for its explanation of the spectra of the most simple element, Hydrogen. Many difficulties were encountered, however, when an attempt was made to extend the theory so that it would explain optical and x-ray spectra of other elements. These difficulties have led to the development of other methods of explaining atomic and molecular phenomena. These newer theories discard the idea of atomic models, but retain the concept of the various energy states of the atom. They deal with the atom as a unit rather than trying to predict the position and motion of any individual part of the atom. In this they are basically sound. One of the most basic laws of logic in physics is that a phenomenon must be defined in terms of the operations required to measure that occurrence. Bohr attempted to predict the position, velocity, and time function of any electron in an atom. It is physically impossible at present to experimentally measure such properties of a moving electron, and therefore such terms as position and time have no exact meaning when applied to an electron. These newer theories look upon the atom as a whole rather than as a dissectible system of several parts. They find for this system certain observable phenomena such as the frequencies of the radiation that it emits or the heats of its chemical combinations.

They have used these data in an endeavor to find mathematical forms of reasoning which permit the results of such observations to be calculated theoretically. This new mathematical approach to the problem of atomic physics has been called Quantum Mechanics. Space does not permit a detailed discussion of this theory. Instead, an attempt will be made to discuss some of the results of the application of this theory to the problem of the spectra of molecules. We shall first examine the experimental evidence of molecular spectra and then attempt to fit a mathematical explanation to this evidence.

An incandescent solid, such as the filament of an electric light bulb, emits radiation forming a continuous spectrum; that is, the radiation contains all possible wave lengths from the long infrared rays to the very short ultraviolet. An energized gas, however, emits a selective spectrum containing only a limited number of different wave lengths. The red light from neon is an example of this. One of the best ways of examining molecular spectra is to study the radiation absorbed by a gas when a continuous radiation is passed through it. It will absorb in its normal state the same radiation it emits when energized. To do this, we make use of the apparatus shown in Figure 1. We first must decide on the part of the spectrum we wish to examine. The apparatus in Figure 1 is

good for the photographic region which includes the ultraviolet, the visible and the near infrared regions.

A continuous source of radiation at A, such as an electric light bulb, supplies the radiation to be examined. This radiation is collected by a lens L and made to pass through the tubes D in a parallel beam. The tubes D are filled with the gas whose absorption spectrum is to be examined. The gas will absorb from the continuous spectrum those wave lengths that are peculiar to its molecular structure. The radiation discharged from the tubes D is reflected by the mirrors M into a dark room that contains the spectroscope and photographic equipment. A lens L is used to focus the radiation on a narrow slit S. The radiation passing the slit S is diffracted by the grating G into the various colors or wave lengths of its spectra. This diffracted radiation is photographed by plates placed on the rail at B. A grating is simply a plate on which are ruled a large number of parallel lines. This apparatus has the property of breaking up light into its various wave lengths; these different wave lengths being focused on the plate rail B at different points. With a grating using 15,000 lines per inch and a plate rail forming an arc of 24 feet radius, it is possible to obtain a dispersion of 2.5 angstroms per millimeter.

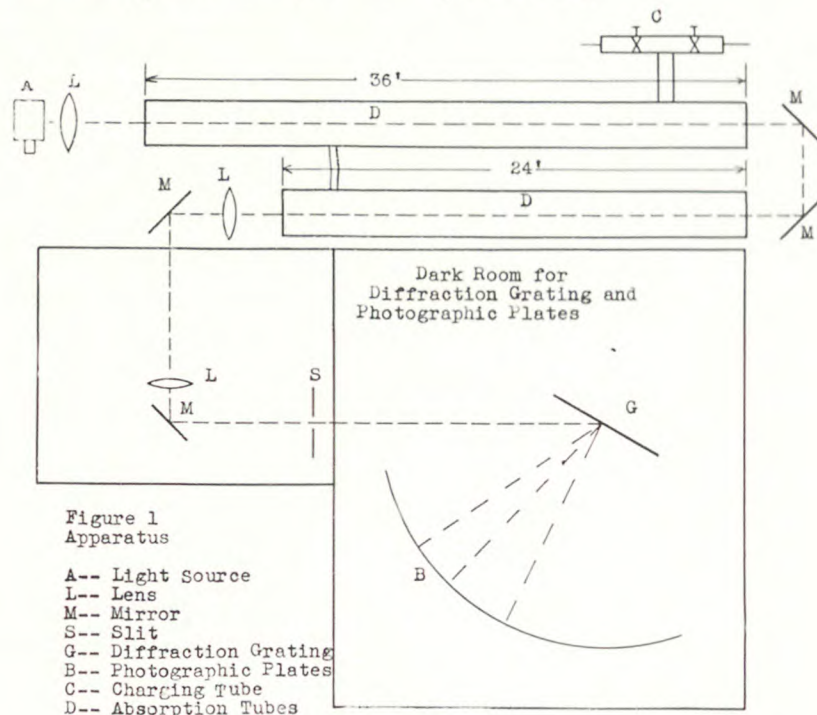


Figure 1



Let us next examine a photograph taken with the above apparatus. Figure 2 is the result obtained when the absorption tube was filled with oxygen gas. On the continuous background of the white light we observe a region where certain wave lengths are missing. This region appears as a series of lines; this series of lines constitutes the absorption band of  $O_2$  centering at 7,600 angstroms. We observe that the band consists of two groups of lines, one to the right and one group to the left of a center. We also observe that each group consists of several pairs of lines, rather evenly spaced. We further observe that one group of lines seems stronger or more intense than the other group.

This band is typical of the molecular spectra due to diatomic molecules like CO. It is the problem of Quantum Mechanics to explain mathematically the results of this experiment in terms of certain physical properties of the molecule, such as its moment of inertia, the spacing of the two atoms forming the molecule, and the force holding these atoms in some equilibrium configuration. Let us briefly examine this mathematical analysis.

Quantum Mechanics deals with the average properties of a large number of molecules, and not the property of any



Figure 2. 7600 Angstrom Oxygen Band; Diatomic Molecule

one body. We can imagine a diatomic molecule as resembling a dumb-bell in form and determine the various ways such a system can absorb energy. One way is to have the molecule rotate about its center of gravity. The theory permits the molecule to rotate with certain definite or "quantized" energy values. Radiation is absorbed when the molecule changes its rotational energy from one quantized energy value to a higher value. The relation between the change of rotational energy  $E$  and the frequency of the absorbed radiation  $\mu$  is

$$E = h\mu \quad h = \text{Planck's constant}$$

The energy  $E$  required to produce changes in the rotation of the molecule is very small, leading to a very small value of the frequency  $\mu$ . Small values of radiation frequency correspond to very large values of the wave length of the radiation. Therefore these rotational changes produce the so-called rotational absorption bands located in the far infrared region at wave lengths of the order of magnitude of 100,000 angstroms.

Assuming that the diatomic molecule resembles a non-rigid rotator of reduced mass  $M$  in which the two atoms are spaced a distance  $r_0$  apart and separate to a dis-

tance  $r$  due to the rotation, we may write the equation for the rotational energy as the sum of its kinetic and potential energies. Using plane polar coordinates, the kinetic energy  $E_k$  is

$$E_k = \frac{1}{2}Mr^2 \left( \frac{d\phi}{dt} \right)^2 = \frac{p^2}{2Mr^2} \quad (1)$$

where  $p$  equals the angular momentum. The potential energy  $E_v$  may be expressed as

$$E_v = \frac{k(r - r_0)^2}{2} \quad (2)$$

The total energy  $E$  then is the sum of (1) and (2) or

$$E = \frac{p^2}{2Mr^2} + \frac{K(r - r_0)^2}{2} \quad (3)$$

Since the centrifugal and centripetal forces must be equal—

$$Mr \left( \frac{d\phi}{dt} \right)^2 = K(r - r_0) \quad (4)$$

In the absence of any external force, the angular momentum  $p$  will be constant and therefore

$$p^2 = Mkr^3(r - r_0) \quad (5)$$

Substituting (4) and (5) in (3) we get for the total energy  $E$  of the system

$$E = \frac{p^2}{2Mr_0^2} \left( 1 - \frac{p^2}{MKr_0^4} \right) \quad (6)$$

Quantum Mechanics now places certain restrictions on the permissible energy changes. These restrictions are incorporated in the following quantum conditions—

$$\oint p d\phi = 2\pi p = jh \quad (7)$$

where  $j = 0, 1, 2, \dots$  (integer) and  $h$  is Planck's constant.

This equation gives us the restricted energy values that the molecule may have. Substituting the value of  $p$  from (7) into (6) we get—

$$E = Bhj^2(1 - u^2j^2) \quad (8)$$

where

$$u^2 = \frac{Mh^2}{4\pi^2 I_0^2 K} \quad \text{and} \quad B = \frac{h}{8\pi^2 I_0}$$

$I_0$  = moment of inertia of molecule. Thus, if  $j$  changes from  $j = 1$  to  $j = 2$  we get an energy change  $E_1$  to  $E_2$  due to a change of rotational energy. As stated before  $(E_2 - E_1) = h\mu$  where  $\mu$  is the corresponding frequency of the absorbed radiation. As  $j$  changes by  $\pm 1$ , equation (8) predicts a series of absorbed radiation evenly spaced. Thus we get the evenly spaced absorption lines of Figure 2.

The absorption band of Figure 2 is due to the above rotational energies of the molecule and also to certain vibrational energies. It is called a Vibration-Rotation Band. In addition to its rotation about its center of gravity, the two atoms of the molecule may vibrate back and forth about some equilibrium position. These two motions may take place at the same time and result in the absorption of much

greater energies. These larger energies correspond to larger values of the absorbed frequencies and to smaller wave lengths of the absorbed radiation. The wave lengths of these bands lie in the visible and near infrared part of the spectrum.

To find the total energy of such a system we add to the rotational energy discussed above that due to the vibration. Assuming that the vibration is harmonic, we get the total energy as the sum of the vibrational kinetic energy plus the rotational kinetic energy plus the potential energy, or

$$E = \frac{1}{2}M \left( \frac{dr}{dt} \right)^2 + \frac{1}{2}Mr^2 \left( \frac{d\phi}{dt} \right)^2 + \frac{K(r - r_0)^2}{2} \\ E = \frac{p_r^2}{2M} + \frac{p^2}{2Mr^2} + \frac{K(r - r_0)^2}{2} \quad (9)$$

where  $p_r$  = linear momentum and  $p$  = angular momentum.

Proceeding as in the case of the rotator described above, we apply certain quantum restrictions and obtain an equation for the total energy similar to equation (8) or

$$E = Whv(1 - xv) + Bhj^2(1 - u^2j^2) \quad (10)$$

where  $v$  = vibrational quantum number 0, 1, 2, ... (integer)

$j$  = rotational quantum number 0, 1, 2, ... (integer)

$$W = \left( \frac{K}{4\pi^2 I} \right)^{1/2}$$

Equation 10, to a first approximation, will give us the various energy values or "Energy Levels" that a diatomic molecule may have due to the absorption of vibrational and rotational energies. It is written in terms of the moment of inertia  $I$  of the molecule, and rotational and vibrational quantum numbers  $j$  and  $v$ . The first term, or vibrational term, is some 400 times larger than the second term, or rotational term. Figure 3 gives a rough idea of these energy levels as computed from equation 10. If  $v = 0$  and  $j$  is given the values of 0, 1, 2, 3, etc., we get the various pure rotation levels marked  $v = 0$ . If  $v = 1$  and  $j = 0, 1, 2$ , etc., we get the first vibrational levels marked  $v = 1$ . And so on, letting  $v$  equal 2, 3, etc., we get higher levels.

As stated before, radiation is absorbed when the molecule goes from one energy level to another. This change in energy  $E$  as shown by the vertical lines in Figure 3, is related to the absorbed frequency  $\mu$  by the equation

$$E = h\mu$$

However, all possible changes between energy levels are not permitted. The theory develops certain selection rules that limit the transitions. Thus the quantum number  $j$  may change only by  $\pm 1$ , and the quantum number  $v$  may change only



from 0 to 1, 0 to 2, 0 to 3, etc. It is further stated that changes in  $v$  must always be associated with changes in  $j$ . Let us see how these rules produce the spectra as shown in Figure 2.

The first band we consider is the pure rotational band found in the far infrared region of the spectra (Band A, Figure 3).

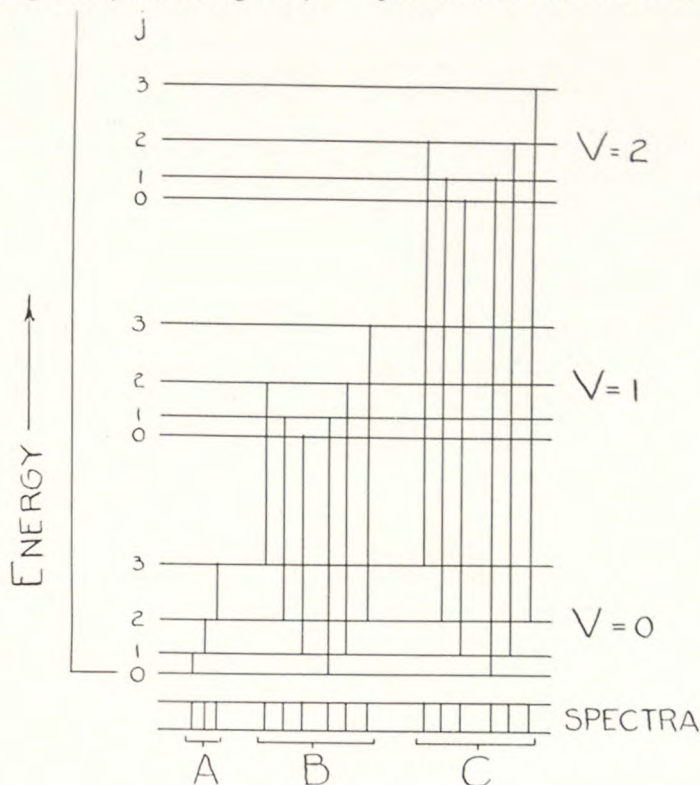


Figure 3

This band is produced by rotational changes only, in which  $\Delta j$  is  $+$  or  $-1$  and  $v = 0$ . This will produce a series of absorption lines evenly spaced, the frequency of the lines being  $\mu = \frac{\Delta E}{h}$ .

The rotation-vibration bands (Figure 2 and bands B and C of Figure 3) are produced when  $v$  changes from 0 to 1 (or 0 to 2, etc.) and at the same time,  $j$  changes by  $+$  or  $-1$ . Thus we may change from the level ( $v = 0, j = 0$ ) to ( $v = 1, j = 1$ ); the corresponding energy change producing a definite frequency of absorption. The following are some of the changes permitted:

- ( $v = 0, j = 1$ ) to ( $v = 1, j = 0$ )
- ( $v = 0, j = 2$ ) to ( $v = 1, j = 3$ )
- ( $v = 0, j = 2$ ) to ( $v = 1, j = 1$ ) etc.

Each energy change produces a corresponding frequency of the absorbed radiation. It is noted that the change  $\Delta j = 0$  is not permitted. If this change were permitted, it would produce a line in the center of the bands B and C. It is thus seen that the theory developed explains the shape and structure of the spectra shown in Figure 2. A series of evenly spaced lines appear on each side of an empty center space.

We next show how the above theory and the experimentally obtained spectra of Figure 2 may be used to determine the moment of inertia and the size of the molecule. From the spectra of Figure 2 we measure the frequency of the various lines by comparing them to some known spectra, such as the lines of the iron spark

spectra. We next identify the various lines by their quantum numbers  $v$  and  $j$  as shown in Figure 3. Knowing the frequency of a line, we find the change in energy to produce this line by the expression  $\Delta E = h\mu$ . This energy change  $E$  is the difference between two energies  $E_1$  and  $E_2$ . These energies  $E_1$  and  $E_2$  may be written in terms of Equation 10, and knowing their differences  $E$ , we may solve these equations for the moment of inertia  $I_0$ . Knowing the moment of inertia, we can compute the spacing of the two atoms forming the molecule. Thus, the problem of the diatomic molecule has been solved.

Space does not permit a more detailed discussion of this theory. The complete details of the development of Equation 10 are quite complex, as are various modifications of this equation to fit a more exact interpretation of the absorption spectra of molecules. The above theory has been extended to cover the spectra of polyatomic molecules. As the number of atoms in a molecule increases, the absorption spectrum increases in complexity and, with it, its mathematical solution.

*Editor's Note:* Professor Frank D. Carvin graduated from the Engineering School

of the University of Pennsylvania, receiving the B.S. degree in 1916 and the M.E. degree in 1924. After a year of industrial work, he served in the army until the end of the war. Following this, he was employed in Power Plant Operation, and later as Instructor of Mechanical Engineering at the University of Pennsylvania. In 1924 he became Assistant Professor of Mechanical Engineering at the Brooklyn Polytechnic Institute. In 1934 he became Professor of Mechanical Engineering and Head of the Department at Newark College of Engineering. In 1924 he started Graduate Work in Physics, receiving the M.A. degree in 1930 from Columbia University and the Ph.D. degree from New York University in 1938. His research work was on the "Band Spectra of Hydrogen Sulphide Gas."

Professor Carvin is a member of several engineering societies and fraternities; he holds a New York State Professional Engineer's license and has done considerable consulting work.

#### COUNCIL ON PUBLIC RELATIONS

Of interest to our Alumni in general are the steps being taken to organize a Council on Public Relations. The Council will have participating groups for the Alumni of the College, and representatives of the Technical School Alumni in addition to having the under-graduates of the College and the Technical School represented by their Student Council groups.

Several preliminary meetings have already been held, and the following men have been named on the Steering Committee for the College Alumni:

W. D. VanderSchaaf, Chairman  
Charles M. Beyer  
Leo Mosch

For the Technical School Alumni:  
Henry Reid, Chairman  
Norbert Bertl  
Charles Carter

Professor C. J. Kiernan was named Executive Secretary.

#### MOTION AND TIME STUDY COURSE

The evening laboratory course in motion and time study offered by the Industrial Engineering Department is now in progress. Although the original limit to the enrollment of the class was extended from fifteen to twenty-one students, it was necessary to refuse the applications of several who applied during the last few days before the course started.

The first session, under the joint instruction of Professor Wilkinson of the Industrial Engineering Staff, and Mr. C. H. Cox, Industrial Engineer with Merck & Co., Inc., Rahway, N. J., was held on Monday, January 30, 1939. President Cullimore and Dr. Lillian M. Gilbreth were present at this opening meeting of the class and spoke briefly on the place of motion study in industry.



## THE ORDEAL OF THE FRESHMAN

By JAMES A. BRADLEY, A.B., A.M.

*Dean and Associate Professor in Chemistry, Newark College of Engineering*

There is much discussion today among writers, talkers, and practitioners in the educational scene as to who should go to college, what he should do when he gets there, and what will be his future after leaving. They wonder whether the young gentleman from the high school or the preparatory school is really adapted to college life; whether he can absorb what will be offered to him; whether he can make use of what he may absorb; and why should he go to college, anyway. As usual, when so many doctors get together, there is confusion. Each one has his own ideas which differ from the ideas of all the others. And meanwhile the enrollment of the colleges continues to grow. It seems to be limited only by the ability of the parents to meet the rather high financial demands of four years of college, and little or no attention is paid to the suitability of the young people for college, and even less to the suitability of the college for the young people.

The question as to who should go to college or, rather, who should be kept out is, of course, a serious one. Its decision may mar the making of a very useful citizen or develop a badly-adjusted individual. But each of us feels that it is a problem for some one else. We say, "I doubt very much whether college will make Jones anything but what unfortunately he is. Four years and a small fortune wasted. Luckily, I have no such worries — or doubts." And so we go to college, not knowing sometimes why we go. We only know that we have been told by our elders and by writers in magazines and by speakers at conventions of educators that higher education is a good thing for us. It not only makes life fuller, they say, but it pays in hard cash. There you have a composite appeal to the idealist and to the more earthy man. And, in spite of a suspicion that some of the champions of higher education have an eye to advertising values, I agree that a college education is vastly worth while, if we can use it.

I believe, although I could not prove it, that it is harder to get through college now than it was twenty years ago. And entrance requirements have, in general, been made stricter. This is a natural consequence of the increase in college enrollment, which has been multiplied by five or six in the past twenty-five years. Whether this increase will continue is a very interesting question. At present about one out of every hundred inhabitants of the United States is in college.

Now, this matter of entering college brings up the question of the high school

and the preparatory school and their function in preparing the student for college. This function is almost the entire object of the existence of the preparatory school. The high school, however, not only trains a certain proportion of its students for college, but at the same time carries on a variety of other types of instruction for the sake of students who have interests and ambitions of all kinds, but are not bound for college.

This type of school is very much in the public eye at present because of the Regents' Inquiry into the character and cost of public education in the State of New York. The survey deals primarily with the State of New York, but by implication it involves the whole school system of the country, since the purpose of education in primary and secondary schools is everywhere the same. Reduced to simplest terms, these aims are: first, to give the pupil in the primary schools the fundamental grammar school education with which we are all familiar and, second, to carry on education in a more diversified manner in the high school so as to make the students adaptable to the complex modern world in which they live. The preparation for college, as has been said, is only one of the functions of a high school, and in some places it is a decidedly minor function. The high school must also educate students whose welfare is as important to the nation as that of the college-bound minority. Thus, an effort is made to adapt the curriculum to all types of ambitions and to most of the levels of interest and intelligence found in the community, the final aim being education for American life.

It is easy to understand how there may be a mental stress felt by the student who passes from such an atmosphere into that of the college or technical school where the aims are more clearly and narrowly defined. To the freshman there is a newness and strangeness about the college. He finds an apparent absence of restraint. He is allowed to come and go with the utmost freedom. He is asked not to stand up when reciting. He is called "Mister." At the Newark College of Engineering he learns that no report of any kind will be made about his work until the middle of November and even at that time it will be in the form of an opinion, not a grade. Furthermore, it will be sent to him and not to his parents. He finds that the faculty favors a "hands off" policy in a great many student affairs. And yet, in spite of the obvious invitation to be at ease, he seems worried and slightly frightened for some weeks. I am not sure why he feels

like this, but it may be that he misses the sheltering attentions of the high school teacher. I remember clearly my own reaction to the first days of college. A group of us from my old school met by appointment at a certain hour on the steps of one of the houses in the Yard. We came, one by one, all very glum. We had been to no classes. College had not been formally opened. We had merely been around making certain preliminary arrangements and absorbing the atmosphere of the place. Then some one said suddenly, "I wish I were back at dear old Latin School." And we went soberly to lunch. This strangeness passes in a few weeks, but while it lasts it may do harm. I have seen it affect some emotionally unstable boys to such an extent that I had difficulty in persuading them not to leave college.

There are, however, other phases of the freshman's transition period which are more lasting and which furnish problems for the dean or personnel officer or others who have to do with the welfare of the student. Sometimes the difficulties arising at this time do not come to light, unless by accident, in spite of searching examinations which are meant to probe the intelligence, the aptitudes, and the physical condition of the boy while he is still a candidate for admission to the college.

Of the problems that arise at this time or, indeed, at any time I should place disciplinary matters last. Not that they are unimportant, but that they are comparatively rare. I feel that they are a small part of our work. In the uncertain world in which we live "bright college days" have gone out of fashion. And perhaps the college playboy never did have a wide existence outside of the imagination of prejudiced elders who have been unnecessarily reactive to high spirits or levity. It was James Russell Lowell, I think, who wrote a satirical description of a faculty meeting at which a group of professors called indignantly for the disciplining of two young gentlemen who had been seen to smile in the Yard that morning.

The more common and more serious problems that confront college officers are those which have to do with the possibility of failure in college. They are, of course, very numerous, changing with the individual, his former life and training, his family, his associates, and his environment. It might be well to consider a few that occur commonly.

One is the problem of the boy's relation to other members of his own family. I have never been inclined to place the blame on one person or another in such cases of



difficulty. The causes are usually obscure and are, perhaps, a product of the storm and stress of the adolescent period when small troubles become big and important, and obsessions of one kind or another grow up suddenly. They come from a world in which, as Chesterton says, "insects walk about in the sun as large as elephants." They may give rise to the most outrageous product of worry and imagination like that of an eminent, vigorous, and very healthy American woman, more in the public eye a few years ago than now, who tells that when she was a girl she was convinced that she was going to become a leper. It is this kind of unreason which causes a wall to grow up suddenly between father and son. Without knowing why, they are impatient with each other. The father says, "He is a fine boy in every way, but he just doesn't seem to confide in me. Perhaps he would listen to you." The boy says nothing or talks of things which you know are not related to the problem. Fortunately these strained relationships do not last. In time the difficulties vanish, the imagination becomes more healthy, new adjustments are made, but the reasons for the friction never come to light. It may have been just another phase of the transition period. The father may not have realized that he no longer had to deal with Johnnie, who had always depended on him so much for advice and help and direction, but with John, who wants to go his own way and make his own plans. One of the things every well-trained father and mother must learn is that at certain periods of their lives they must lose their children in order to find them again. It is pleasant to listen to a child of from three to seven who keeps saying, "What can I do? Where shall I sit? Why must I eat this?" But only mental invalids remain children as they approach maturity.

Of course, this period of transition from high school to college is also a time of introduction to new ways of doing things, of developing an intellectual activity in some field, of being burdened with heavier tasks, of doing more intensive thinking and more extensive reading, of learning from lectures which pass day by day from subject to subject instead of being drilled over and over again on the same topic. This may be a heavy task even for a well-prepared and well-adjusted student. But what is it for the boy who comes to college feeling that he "might like to study engineering, but is not sure of it." Many do not awaken intellectually before coming to college. Those who are not awakened soon after entering are not likely to remain in college long.

Most probably a student will do best if he can study a subject in which he is very much interested, not something which his parents or teachers think he should study. The boy's choice may be a mistake, and,

if so, it must be remedied early. But the choice of his elders, if it conflicts with the boy's inclination and aptitude, is more likely to be disastrous. I feel that the safest course is to let him prepare himself for the work he likes best and not to force him to become an accountant or a sales manager because some one says that these earn a great deal of money.

If a boy does not know what he wants to do by the time he gets to college, and this sometimes happens, it is wise for him to postpone his choice of a course to as late a date as possible and in the meantime to look around. The added maturity that comes with a year in college, the contact with different types of men who are active in various fields, and the orientation that freshmen usually get in these days will combine to make his choice easier and probably more successful. This matter of waiting to decide is more valuable if there is a fair variety of courses given in the first year. In most engineering schools, including the Newark College of Engineering, this condition is found. The first year is the same for all courses and it offers fundamental work which later forms the basis for all types of engineering. Perhaps it would be well if the separation into the different engineering branches could be put off until the end of the second year. At Newark this is almost the case, as an examination of the catalog will show. But by the beginning of the sophomore year we do at least make a start in the separation of the students into the four departmental groups.

Another common cause of failure or trouble for the freshman and also for the men further along is the burden of excessive outside activity. Too much attention to athletics, too many committees, too many clubs or fraternities, too much time given to outside work as a means of financing the college course, and suddenly a man finds that his college work has gone all to pieces and he has to stop suddenly and decide which he must give up, college or the other things. Sometimes it is decided for him, after the grades of the mid-year period come out. These outside interests are of great value in developing self-reliance, or executive ability, or traits of leadership, but they can hardly be looked on as the first concern of the man in college. The practice of athletics can be overdone, can take too important a place in the college scene, and its real purpose can be forgotten. James Truslow Adams in discussing the role of sport in the development of British character, says in his *Building the British Empire* that outdoor games are "played between opposing teams and from this fact come certain notable traits, such as the characteristic English one of compromise. Unless games are all to end in fights and bloody noses, there must grow up a willingness to give

and take, to accept decisions in good spirit whether winners or losers . . . Applied to politics, the British eventually found that an orderly opposition in Parliament was as necessary to Parliamentary self-government as was the Government temporarily in power." This is a much saner point of view than the "win-or-die" one which is so common. And much more valuable to the training of the student for life in the modern world.

And it is this difficult modern world that they must be trained for, a world which at present is more in need of the spirit of coöperation than ever before. The safe, secure places in society that so many had in the past seem to be quite all gone away. The present world is very unsafe, but it is offering one of the most exciting periods of history. Whether or not this is a pleasant prospect depends on our intellectual make-up; whether we have courage, self-reliance, and resourcefulness.

These are the qualities that must be fostered, not only by leaders but by the average man, if the future is to be an improvement on the past.

#### OUR GRADUATES CONTINUE ACADEMIC WORK

By PROFESSOR HENRY H. METZENHEIM

Recently we mailed question forms to a number of the graduates of Newark College of Engineering to determine details about advanced academic work taken by them in other institutions. The replies have come in promptly and while more returns are expected, a sufficient number are now on hand to indicate general trends.

Approximately one hundred graduates have taken or are taking advanced work in other institutions in the period of the last five years. Generally the choice of subjects depends upon the type of professional work in which the graduate has found his connection with Industry.

In most cases the academic studies are taken also for credit toward the Master's and Doctor's degrees. A considerable number of men have completed the work for the M.S. or M.A. degrees.

The Colleges and Universities selected by our men for their advanced work are scattered widely, including, besides the schools in the metropolitan district, others located in California, Massachusetts, Michigan, and North Carolina.

The institutions mentioned most frequently in the replies are: Columbia University, Massachusetts Institute of Technology, New York University, Polytechnic Institute of Brooklyn, Stevens Institute of Technology.

Graduates who have not received our question form are urged to write to the Secretary of the Committee on Transfers for Graduate Work at the College.



# INTEGRAL EQUATIONS

## Motion of a Chain Within a Smooth Fixed Tube

By BEDROSS KOSHKARIAN, A.B., A.M.

Professor in Theoretical and Applied Mechanics, Newark College of Engineering

In the October issue of the NEWARK ENGINEERING NOTES we gave a brief discussion of this problem, assuming that the equation of the fixed curve (tube) and the density of the chain were given. The solution of that problem led us to an *ordinary differential equation of the first degree and the second order*.

In this paper we shall discuss briefly the inverse problem: To determine the distribution of density of the chain so that it shall move within the tube in a prescribed manner. The problem so stated leads to *integral equations*.

On account of the wide range of applications of integral equations in general and their application to the present problem in particular, it may be desirable first to introduce to our readers the mathematical forms which are called integral equations.

Equations of the form

$$(I) \quad f(x) = U(x) + \lambda \int_a^b K(x, \xi) U(\xi) d\xi$$

in which the unknown function  $U$  enters under the integral sign as well as outside of it, are called integral equations of the *second kind*, and equations of the form

$$(II) \quad f(x) = \lambda \int_a^b K(x, \xi) U(\xi) d\xi$$

are called integral equations of the *first kind*. If the limits  $a, b$  of the integrals are both constants, the integral equations (I) and (II) are said to be of the Fredholm type, but if  $a, b$  are not both constants, the equations take on the forms

$$(III) \quad f(x) = U(x) + \lambda \int_a^x K(x, \xi) U(\xi) d\xi$$

$$(IV) \quad f(x) = \lambda \int_a^x K(x, \xi) U(\xi) d\xi$$

and they are called integral equations of the Volterra type.

The functions  $K(x, \xi)$ , called the *Kernel* of the integral equation, and  $f(x)$  are given.  $\lambda$  is a constant, real or imaginary. Solving any one of these integral equations means finding the unknown function  $U(x)$ .

For the general methods of solving integral equations our readers are referred to the following excellent works:

V. Volterra—"Leçons sur les équations intégrales et les équations intégral-différentielles."

D. Hilbert—"Grundzüge einer allg. Theorie der linearen Integralgleichungen."

V. Volterra et J. Pérés—"Théorie Générale des Fonctionelles." Three volumes.

M. Bôcher—"An introduction to the Study of Integral Equations."

Our readers will find an extensive bibliography at the end of the first volume of MM. Volterra and Pérés's work. In the third volume the eminent authors apply the general theory to mechanics, mathematical physics, biology, statistics, and political economy.

Hoping that some day our biologists, statisticians and political economists will also be mathematicians, we shall begin with the discussion of our chain problem.

Our discussion will closely follow that of M. A. Myller (*Nouvelles Annales de Mathématiques*, 1909).

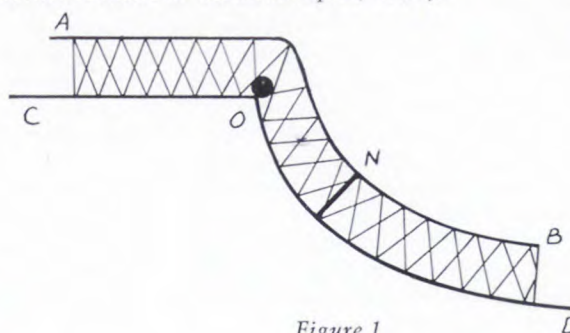


Figure 1

Let us suppose, with M. Myller, that a heavy chain of length  $a$ , supported partly by the horizontal line (tube) CO and partly by a given curve (tube) OD, Fig. 1, is sliding in the direction COD, in a vertical plane. We take a vertical axis OY directed downward. Let  $S$  denote the arc of the curve OD, measured from the fixed point O to a point of the curve with ordinate  $y$ . Then the equation of the curve is  $y = U(S)$ .

Let  $p$  be the arc OB of the chain measured from O to the end B of the chain. The position of the chain will be known if  $p$  is known.

Let  $w$  be the arc BN of the chain, measured from B to the point N of the chain. Then the ordinate of the point N is  $y = U(p - w)$ .

Let  $\psi(w)$  be the density, supposing it to be known for the time being, of an element  $dw$  of the chain at N, at a distance  $w$  from B.

To derive the equation of motion of the chain we shall use the work-energy equation,  $d \frac{\Sigma mv^2}{2} = dU$ .

When the chain slides a length  $dp$ , the elementary work done by the weight of  $dw$  is

$$g \psi(w) dw dy = g U'(p - w) \psi(w) dw dp.$$

The work done by weights of the elements of the chain lying on CO is zero, and the work done by the weights of all the elements, therefore, is

$$g dp \int_0^p U'(p - w) \psi(w) dw$$

The kinetic energy of the whole chain is

$$\frac{\Sigma mv^2}{2} = \frac{1}{2} \Sigma m \left( \frac{dp}{dt} \right)^2 = \left( \frac{dp}{dt} \right)^2 \int_0^a \psi(w) dw = \frac{1}{2} M \left( \frac{dp}{dt} \right)^2$$

$M$  being the total mass of the chain.

The work-energy equation becomes

$$M \frac{d^2 p}{dt^2} = g \int_0^p U'(p - w) \psi(w) dw \quad (A)$$

which is the differential equation of motion when  $\psi(w)$  is known.



Now let us suppose that the function  $\psi(w)$  is undetermined but the acceleration of the chain is a given function of  $p$ , viz.:

$$\frac{d^2 p}{dt^2} = F(p) \quad (a)$$

The equation (A) then becomes

$$\frac{M}{g} F(p) = \int_0^p U'(p-w) \psi(w) dw \quad (B)$$

which is an integral equation of the *first kind* of the Volterra type, by (IV), where  $\psi(x)$  is the unknown function. By the theory of integral equations, (IV) always admits a solution. It is, therefore, possible to find a law of density  $\psi(w)$  so that the chain will move with an acceleration given by (a).

*Example.* Let us suppose that the tube OD is a cycloid, then, as we have already seen,

$$y = \frac{S^2}{8R}$$

The equation (B) becomes

$$\frac{4RM}{g} F(p) = \int_0^p (p-w) \psi(w) dw \quad (b)$$

This integral equation can be solved by differentiating twice by the well-known formula for differentiating an integral, viz.:

$$\text{If } G(\alpha) = \int_a^b f(x, \alpha) dx,$$

where  $a$  and  $b$  are functions of  $\alpha$ , we have

$$\frac{dG}{d\alpha} = \int_a^b \frac{\partial f}{\partial \alpha} dx - f(a, \alpha) \frac{da}{d\alpha} + f(b, \alpha) \frac{db}{d\alpha}$$

Differentiating (b) once, we get

$$\begin{aligned} \frac{4RM}{g} \frac{dF}{dp} &= \int_0^p \frac{\partial}{\partial p} (p-w) \psi(w) dw - (p-0) \psi(0) \frac{d(0)}{dp} \\ &+ (p-p) \psi(p) \frac{dp}{dp} \\ &= \int_0^p \psi(w) dw \end{aligned}$$

Differentiating again, we get

$$\frac{4RM}{g} \frac{d^2 F}{dp^2} = \int_0^p \frac{\partial}{\partial p} \psi(w) dw - 0 + \psi(p) \frac{dp}{dp}$$

Hence

$$\frac{4RM}{g} \frac{d^2 F}{dp^2} = \psi(p)$$

which is the solution required.

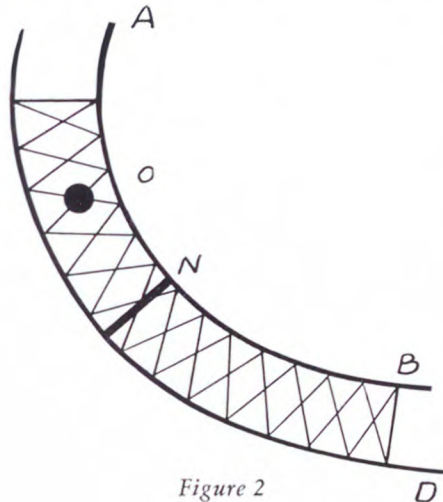


Figure 2

Let us now consider the case when the chain of length  $a$  slides only within a fixed tube AD, Fig. 2.

Let  $p$  be the arc BO, measured from the fixed point O on the tube  $y = U(S)$ ,  $w$  the arc BN measured from the end B to any point N of the chain and  $\psi(w)$  its density at N.

In this case the work done by the weights of all the elements of the chain is

$$g \int_0^a U'(p-w) \psi(w) dw,$$

and the work-energy equation becomes

$$M \frac{d^2 p}{dt^2} = g \int_0^a U'(p-w) \psi(w) dw \quad (C)$$

$\psi(w)$  being the unknown function.

$$\text{Let us again suppose that } \frac{d^2 p}{dt^2} = F(p),$$

where  $F(p)$  is a given function.

The equation (C) becomes

$$\frac{M}{g} F(p) = \int_0^a U'(p-w) \psi(w) dw \quad (D)$$

which is an integral equation of the *first kind* of the Fredholm type, by (II). It follows that our problem is possible only when Fredholm's integral equation (II) has a solution. But this equation has no solution in general, the possibility of a solution depending upon the forms of the functions  $U(S)$  and  $F(S)$ .

*Example.* Let us again suppose that the tube is cycloidal. We have

$$y = \frac{S^2}{8R}, \text{ and the equation (D) becomes}$$

$$\frac{4RM}{g} F(p) = \int_0^a (p-w) \psi(w) dw \quad (E)$$

Since for any  $\psi(w)$  the second member of (E) is a linear function of  $p$ ,  $F(p)$  must also be a linear function of  $p$ . Hence, for the possibility of the problem, we must have

$$F(p) = Ap + B, \quad A, B \text{ constants} \quad (c)$$

If this condition is satisfied, the equation (E) will admit infinite number of solutions, and there will be infinite number of functions  $\psi(w)$  for which the chain will move in the prescribed manner (c).

Let us now try to determine a distribution of density so that the difference between the acceleration of the chain and the density  $\psi(p)$  of the element of the chain passing through the point O varies according to a given law  $F(p)$ , viz.:

$$\frac{d^2 p}{dt^2} - \psi(p) = F(p) \quad (d)$$

The integral equation (A) becomes

$$F(p) = -\psi(p) + \frac{g}{M} \int_0^p U'(p-w) \psi(w) dw$$

and the integral equation (C) becomes

$$F(p) = -\psi(p) + \frac{g}{M} \int_0^a U'(p-w) \psi(w) dw$$

These integral equations are of the second kind by (I) and (III), of the Volterra and the Fredholm type respectively. By the theory of integral equations we know that in general both of these equations admit a solution, and the chain can move in the prescribed manner (d).



# WHAT HAS HAPPENED TO OUR 1938 GRADUATES

By ROBERT WIDDOP, B.S.

*Associate Professor and Director of Industrial Relations, Newark College of Engineering*

The Industrial Relations Department at the College completed a survey in November, 1938, of the men who graduated from the day courses in June, 1938. This was done primarily to determine how this group of 93 were situated so far as employment was concerned.

It is interesting to note the results of the survey. 82 replies were received and of this number about 84% were employed. About 30% of the group are continuing their work with firms which had employed them as co-operative students during their senior year at the College.

In view of the fact that industrial conditions had not been too stable, the employment situation with regard to the most recent graduating group is not unfavorable.

With the tabulations from this survey, and in the fact that the college has, in many instances, been helpful to graduates seeking employment, the Institution can take considerable satisfaction.

The Department is actively in touch with the industrial situation, seeking the industrial experience placements required of the Senior group, and looking to similar placements for underclassmen of the "Honors Option." It maintains also a "clearing house" through which employers and engineering applicants, both graduate and undergraduate, are brought together. The present situation is distinctly hopeful.

Of the class of '38 four are employed in company training or cadet courses. These include: Martin G. Dietl (Ch.) with the Crane Company in Chicago; John N. Garratt (Ci.) with Wallace & Tiernan Company in Belleville; Samuel E. Johnson (M.) with the Consolidated Edison Company in New York; Glenn O. Neimeyer (Ch.) with the Lowe Paper Company in Ridgefield Park, N. J.

Of the group remaining with co-operative concerns, we have Bertram H. Allison (Ch.) and Stanley Bredder (Ch.) with the American Hard Rubber Company in Butler; Ralph P. Benn (M.) with the Western Electric Company in Kearny; Paul J. Giordan (Ch.) with the National Grain Yeast Company in Belleville; Richard W. Grundman (M.) with the Richardson Scale Company in Clifton; James E. Tuohig (Ch.) and John W. Jacobson (M.) with Davis Engineering Company in Elizabeth; J. Warren Johnson (E.) with Richard Best Pencil Company in Irvington; John V. Silliman (M.) with American Type Founders in Elizabeth;

Carl J. Tylka (Ch.) with Warner Chemical Company in Carteret; Edmond V. Tyne with Irvington Varnish & Insulator Company in Irvington; Dominick Restuccia (M.) with Walter Kidde & Company in Bloomfield; Messrs. William J. Brown (Ci.), Earl G. Gieser (Ch.), Calvin H. Kyte (E.), and Austin J. Mortimer (E.) with Federal Shipbuilding & Dry Dock Company; F. W. Brunkhardt (M.), Theodore Feuerbach (M.) with Clark Thread Company in Newark and Herman Altschule (E.) with the Jewel Lamp Company in East Newark.

The remainder of the group are employed as follows: Angelo D. Alessi (Ch.) with the Flintkote Company in East Rutherford; Charles J. Becica (M.) with the Martin Company in Fort Lee; Herman Blackman (Ch.) with United Auto Spring Company in Bronx, N. Y.; Howard R. Booth (M.) Departmental Assistant, Mechanical Engineering Department of N. C. E.; Charles A. Bumpus (Ch.) with the Resistoflex Company in Dover; John W. Butterworth (E.), Herbert Schor (E.) and Elliott Mehrbach (E.) with the Federal Telegraph Company; Carlo F. Cateno (Ch.) with the Essex Chemical Company; Otell M. Cocchiarella (Ci.) with Filtration Engineers, Inc.; Edward C. deParrie (M.) with Joseph A. Cogbill Company; Hans Enard, Jr., (M.) with the McKiernan-Terry Corporation in Kearny; Walter H. Esselman (E.) with National Union Radio Tube Corporation in Newark; Carman W. Garrison (Ci.) with the Pennsylvania Railroad; Stuart C. Hand (Ch.) with the Compensation Rating Bureau; William Hausmann (M.) with H. Boker & Company; John H. Hind, Jr., (M.) with the Kauai Pineapple Company in Hawaii; Edward F. Houston (M.) with the Wright Aeronautical Corporation in Paterson; Henry Jasik (E.) with the Bureau of Ordnance, U. S. Navy, Washington; James H. Johnston, Jr., (E.) Departmental Assistant Electrical Department, N. C. E.; John H. Johnstone (Ch.) with Tungsten Products Company in North Bergen; William J. Junikewicz (Ch.) Flintkote Company in East Rutherford; Walter A. Kafka (Ci.) Traffic Survey, Town of Irvington; John G. Kronseder (Ch.) with the Grasselli Chemical Company in Grasselli; Melville H. Lyman, Jr., (Ci.) Lock Joint Pipe Company in East Orange; Henry F. Macchi (Ch.) with Bakelite Corporation in Bound Brook; Jacob Mautner, Jr., (M.) and Frank N. Meeker, Jr., (M.) with American Type

Founders in Elizabeth; Lane S. McKone taking graduate work at Stevens; Albert E. Merwin (Ch.) with the Celotex Corporation in Metuchen; Francis B. Northrup, Jr., (M.) with Swift & Company; Henry K. Odenwald (Ch.) with the U. S. Industrial Alcohol Company in Newark; Edward A. O'Mara (M.), Frank C. Kreidler, Jr., (M.) and George P. Roeder (M.) with Federal Shipbuilding & Dry Dock Company; Jerome L. Polaner (M.) Departmental Assistant at N. C. E.; Miss Mildred A. Preen (E.) with E. L. & A. G. Preen Company in Somerville; Peter Prychka (Ch.) with the Calco Chemical Company in Bound Brook; Paul E. Schwartz (Ch.) with Motor Lubricants, Inc., Newark; Irving Stokes (E.) with Tung-Sol Lamp Works; LeRoy E. Sullivan, Jr., (Ci.) with the Essex County Park Commission; John A. Taska (M.) with Ford Instrument Company in Long Island City; Robert Ward (Ch.) Eclipse Aviation Corporation, Bendix, N. J.; and Edward W. Wraith (M.) Departmental Assistant at N. C. E.

## THE STUDENT ENGINEERING SOCIETIES

The Student Chapter of the American Institute of Chemical Engineers at its meeting in February heard a talk on SAFETY by Mr. Stanley Warzala, Director of Safety of the Calco Chemical Company. Mr. Warzala discussed particularly the planning of safety measures in an industrial organization and the improvement in working conditions during the past twenty years.

At the March meeting Dr. H. L. Bender of the Bakelite Corporation talked on RESINS. He developed the subject from the point of view of the internal structure of modern plastic materials and showed a number of illustrative slides. Dr. Bender is the author of a number of papers dealing with plastics.

(Reported by Dean James A. Bradley.)

The Newark College of Engineering Student Chapter of the American Society of Civil Engineers held a "Father and Son" night at the meeting of March 6. The meeting was well attended by the members, many of whom brought their fathers.

Mr. Roger Gilman, the speaker for the evening, is the Chapter's Junior Contact member, and his father, Mr. Charles Gilman, is Senior Contact member, thus extending the father and son theme. Mr. Roger Gilman, who is a statistician on



traffic matters for the Port of New York Authority, gave a very interesting and instructive talk on the subject "Engineering Aspects of Highway Safety." He began his talk by tracing the development of traffic safety methods from the Roman times to the present day. Mr. Gilman stressed the importance of the three "E's" of highway safety. Engineering, Education, and Enforcement, if carried out effectively, reduce the number of accidents on highways. Mr. Gilman showed slides to illustrate the various engineering methods that are being used to provide more safety on the modern highways.

A resolution concerning honorary membership in the Student Chapter was proposed by President George A. Valente and unanimously adopted by the members. The resolution as expressed by Mr. Valente follows: "Resolved, that this Chapter of the American Society of Civil Engineers confer honorary membership on the following in deep appreciation of the services and support which they have given the chapter.

President Allan R. Cullimore, Head of the Newark College of Engineering.

Professor Harold N. Cummings, Head of the Department of Civil Engineering.

Mr. Charles Gilman, Senior Contact member of the Chapter, and Vice-President of the Massey Concrete Products Company.

Mr. Clarence W. Dunham, Assistant Engineer with the Port of New York Authority.

(Reported by Paul Carlino, Secretary of Student Chapter, A. S. C. E.)

On March 7 Mr. Vincent Vitale, a graduate of the Newark College of Engineering, Class of 1928, was the speaker at a meeting of the Student Branch of the Society for the Advancement of Management. Mr. Vitale, now a member of the Industrial Engineering Department at the Western Electric Company, spoke on "Time Standards."

(Reported by R. B. Foster, President of the Student Branch, S. A. M.)

#### TEXTBOOK ON HYDRAULICS BEING REVISED

The textbook on "Elementary Hydraulics" by Professor Harold N. Cummings and Professor Robert Widdop, both of Newark College of Engineering, is now being enlarged and revised.

The book has been used as the textbook on Hydraulics at the College for the past five years.

A review of the book will appear in a coming issue of NEWARK ENGINEERING NOTES.

#### MECHANICAL ENGINEERS MEETING IN NEWARK

On Tuesday evening, March 14, the Metropolitan Section of the American Society of Mechanical Engineers held a general meeting in the Public Service Electric & Gas Company's Auditorium in Newark, at which President Allan R. Cullimore presided. This meeting was the first of a series of meetings to be held in New Jersey for the benefit of the New Jersey members of the American Society of Mechanical Engineers. The meeting was arranged by Dr. Frank D. Carvin, of the Mechanical Engineering Department of the Newark College of Engineering.

The topic of the meeting was "Properties of Metal at Elevated Temperatures." Dr. Richard F. Miller, of the Research Department of the U. S. Steel Corporation, Kearny, New Jersey, delivered the paper. Dr. Miller is a recognized expert in this field, and his paper was an excellent presentation of the general problem of creep in metal and the effect of temperatures on both creep and corrosive properties of metal. The paper gave the result of several years of research on this subject conducted in the laboratory of the U. S. Steel Corporation.

Dr. R. W. Moore, of the Socony-Vacuum Oil Company, Mr. C. R. Brophy, of the International Nickel Company, and Mr. J. B. Romer, of Babcock and Wilcox Company, presented formal discussions of

the paper. These various discussions amplified Dr. Miller's paper and gave some of the results of independent research on this subject.

The meeting was well attended—some 420 New Jersey members of the American Society of Mechanical Engineers were present. About 60 of these were students in the various colleges in New Jersey who are members of the Student Branches of the A. S. M. E.

The success of this meeting has led the Program Committee of the A. S. M. E. to definitely decide on a rather active New Jersey program. It is hoped that those New Jersey members of the A. S. M. E. who approve of this schedule will get behind the movement and actively support the program.

A second meeting is being planned for Wednesday, May 17. Plans have not been completed yet, but the tentative program calls for Commissioner Byrne of Newark to be the principal speaker. The proposed topic is "The Relation of Engineers to Public Service." This promises to be a very interesting meeting and we hope for a large attendance.

#### ALUMNI PERSONALITIES

Joseph Bailey, a graduate of Newark College of Engineering in Mechanical Engineering with the Class of 1937, has been a member of the General Electric Test Group at Schenectady for nearly two years.

In the current issue of the *P. T. M.*, a General Electric publication, Mr. Bailey's picture is shown on the cover together with those of two recent graduates of other colleges. All three men are shown testing a water wheel generator for core loss.

Clifton J. Keating has been employed as an Engineer with the New Jersey Bell Telephone Company since 1928 when he graduated in Mechanical Engineering. Mr. Keating is also President of the Woodside Building and Loan Association of Newark and has been actively interested in this type of work for several years.

## WHAT OUR READERS SAY

#### THEY LIKE OUR ARTICLES

One of our leading digest magazines has again requested permission to reprint articles that have appeared in NEWARK ENGINEERING NOTES.

The last request received was for the following articles that appeared in the February issue: "They Used Their Heads" by Malcolm Eagles Runyon and "Professional Engineers and Land Surveyors" by Allan R. Cullimore.

To the Editor:

I have examined the succeeding issues of NEWARK ENGINEERING NOTES with growing interest and pleasure; it is a publication of which we can well

be proud. I find the modernistic and expressive cover designs on the October and November issues very appealing and certainly quite appropriate. I am also pleased to find that you intend to limit the advertising to a few pages only: I hope that you will maintain this policy. The devotion of the last few pages to criticisms and discussions is also an excellent idea, as it affords an opportunity for those of us who find it difficult to visit the school to question and discuss views and conclusions set forth in the various articles, and thereby maintain close contact with academic activities and former associates whom we were loathe to leave upon graduation, and with whom we can again converse

through the medium of this pamphlet.

However, although the format and scope are very pleasing, the most satisfying feature of the entire booklet is the series of technical articles which are so well written, and whose subject matter is necessarily most interesting to us.

I am certain that this publication will give our school the finest advertising possible and will make us even more proud of our Alma Mater than we have been heretofore—if possible.

Very truly yours,

CHARLES DANTIF.

Haledon, N. J., January 9, 1939.



SOME ELEMENTS OF MATRICES  
INDICATED FROM ANALYSIS  
OF 4-TERMINAL NETWORKS

*Editor's Note:* The above article, written by Professor S. Fishman, appeared in the February issue of NEWARK ENGINEERING NOTES.

Professor Albert A. Nims of the Electrical Department says:

The interest of these correspondents, from the point of view of practical application, in the development of this powerful tool for theoretical analysis is most gratifying. In the College our emphasis is on the understanding, expression, and computation of the quantitative relationships in circuits that are too complex for the simple methods in common use. It is by discussion from different points of view that the essentials are separated from the incidentals and shaped into useful, practical forms.

To the Editor:

Here are some comments on Professor Fishman's article entitled "Some Elements of Matrices Indicated from Analysis of 4-Terminal Networks." Material of this sort is extremely valuable from a theoretical viewpoint, and is necessary for the progress of the art.

I happen to be responsible for a large amount of the electrical calculations made in this Company and therefore I naturally looked at it from the viewpoint of application to my work. In the first place, the title of the article mentions 4-terminal networks and I fail to see a diagram showing what I believe is generally considered a 4-terminal network. I would call each individual one a 2-terminal network, and the most terminals I can find in one network are the two shown in Figure 2, each of which I would consider a 3-terminal network.

The use of the general circuit constants A, B, C, D is restricted to a 2-terminal network, and this considerably restricts the use of these constants. So far, it has not been necessary for me to resort to these constants. We have two calculating tables here, and we find that we can obtain answers more quickly and more accurately by leaving the System diagram in as complete a form as possible and thereby using up to 9 terminals on the alternating-current table and up to 31 terminals on the direct-current table. The use of a calculating table may not be classed as a mathematical method, but it does give answers in a much shorter time and with better accuracy than by mathematical methods. There is always a question concerning the accuracy of a solution which requires a large number of arithmetical operations.

I might add that one problem we have been wondering about is an exact method for converting a 5-terminal mesh network in which each terminal is connected through an impedance to every other terminal, into an equivalent 5-terminal star. Such a conversion would be useful in our calculating table work. We have an approximate method which can be used when necessary, but we are still looking for a more exact solution.

It is quite possible that I am placing too much emphasis on the practical problem of getting answers to every-day problems. I do realize, however, the necessity for theoretical work such as is presented in Professor Fishman's article and I certainly would be in favor of continuing work of this sort. It is my general feeling, however, that this highly mathematical work would be of more value to the industry and to the individual if it could be put into simpler terms. I have been giving lectures on power transmission here in the Company during this past winter, and I find that the men generally prefer material in easily absorbable form.

Once again, let me thank you for the copy of NEWARK ENGINEERING NOTES.

Yours very truly,

RAYMOND C. R. SCHULZE

Public Service Electric and Gas Co.

Newark, N. J., March 9, 1939.

To the Editor:

I wish to advise that a copy crosses my desk monthly and I usually find an article of interest in it. I read Professor Fishman's article on 4-Terminal Networks and although I have never specialized in the use of determinants or matrices, I found the relationships given very interesting. In fact the relationship for Figure 1 is a simple algebraic combination but seems to be somewhat complicated. On the other hand the combination in Figure 3 appears to be quite simple with matrices while it is complicated algebraically.

In dealing with networks we have no difficulties with simple series or parallel combinations or for star and delta transformations. We do, however, have difficulty with higher than what Professor Fishman calls 4-terminal networks so that most of our work is done on a-c or d-c calculating tables where the mathematical work is exceedingly simplified. However, even with the facilities of the calculating table we occasionally have combinations which are difficult to reduce and a certain amount of reduction is necessary in order to represent the problem on the board due to the size of the board being limited. Professor Fishman might find it interesting to address himself to the problem of solving the general case of network where every terminal connects to every other terminal. This appears to be a problem for which there is no general rigid solution.

Very truly yours,

HOLLIS K. SELS

Transmission and Substation Engineer  
Public Service Electric and Gas Co.

Newark, N. J., March 17, 1939.

To the Editor:

The letters which you showed me from Messrs. Sels and Schulze of Public Service, pertaining to my article on Matrices contain some significant comments. Outstanding in both letters is the assertion that the use of matrices, as indicated, does not apply to obtaining specific solutions for the particular transmission systems to which these gentlemen apply themselves.

As indicated in the paper, matrices are used to represent relationships between groups of variables. A matrix does not have a particular numerical

value; it is an operator, chiefly used for transforming one group of variables to another so that certain physical conditions obtain.

Matrices and tensors (the same thing called by another name and dressed somewhat differently) have been used with great success in relativity and other branches of modern physics. Only recently have they been applied to electric circuits and machines. Noteworthy is Gabriel Kron's work on tensor analysis which appeared in the technical journals about two years ago and recently was published in book form. Perusal of this work indicates that the procedure has many possibilities.

For arriving at numerical results in a particular power network with a number of interconnections, matrices and tensors do not provide specific aid. But for establishing the equivalence between mesh-connected and star-connected networks these methods become powerful tools. Kron's work has much to do with such equivalences; it is one of the high spots of his tensor analysis.

Your correspondents' reference to the use of their calculating tables for analyzing system performance leads to wishful thinking on my part which may become a reality through the application of tensor analysis. As engineers, we seek machines which will perform our physical and mental tasks. The Public Service group is well blessed with these excellent calculating boards on which they have been pioneers. Those of us who labor on the analysis of circuits would like to have machines which will operate and give results as well as calculating boards do. Perhaps by utilizing the rectangular and square configurations which characterize matrices a machine handling groups of relationships may be devised.

Please convey my appreciation to Mr. Sels and Mr. Schulze for the interest which they have displayed in their letters and for the suggestion that the problem of equivalent mesh and star circuits be analyzed.

Very truly yours,

S. FISHMAN

Assistant Professor of  
Electrical Engineering

COLLEGE GUIDANCE  
FOR ENGINEERS

This article, written by Professor Robert Widdop, appeared in the October, 1938, issue of NEWARK ENGINEERING NOTES.

Several interesting and instructive discussions have been received. Let us quote:

I have read Professor Widdop's comprehensive article on Guidance for Engineers and find myself quite in accord with his point of view in the aims of the work, as well as in its scope. His method of procedure in orientation as a "continuous process" is especially important. There are many who believe it should continue through "the second job" in order to catch first failures, if any, and reinstate self-confidence. This also is a guide in his direct orientation work on the undergraduate level.

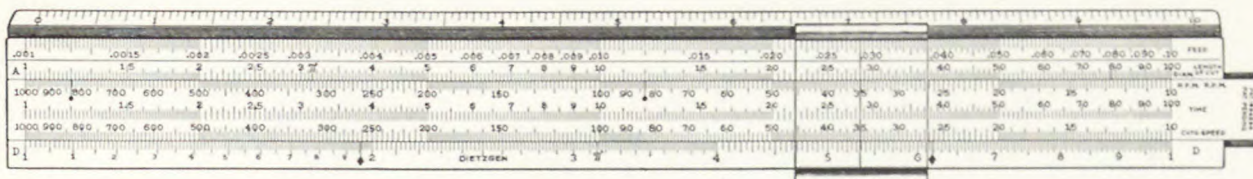
I appreciate your thoughtfulness in sending me the article. With best wishes for continued success, I am

Very truly yours,

GEORGE H. BLACK, *Provost*,  
University of Newark.



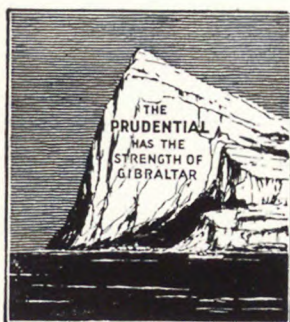
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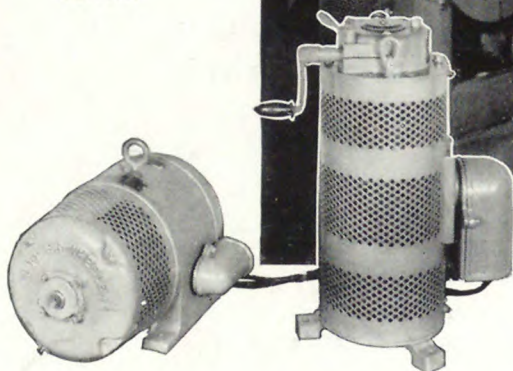
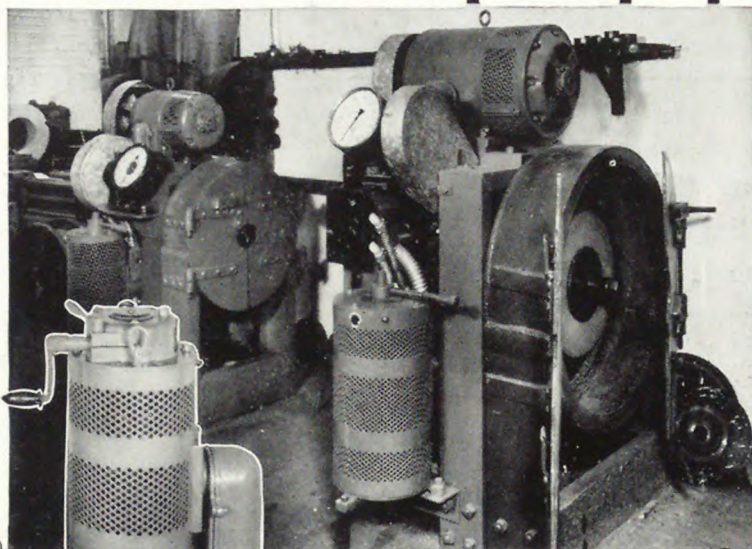
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